Code # 445
(for office use only)

NEW JERSEY

1999-2000
Guidelines and
Application

BEST PRACTICES

Deadline for Application to County Office:
NOVEMBER 22,1999

Category Science (Application is limited to one category. See page 3 for details.)
Practice Name MATS - Mathematics As a Tool of Science (A Team Experiment)
Number of Schools with Practice 1 (If more than one school or district, read and complete information on page 2.)

County	Morris
District (Proper Name)	Roxbury Twsp Public Schools — School District
District Address	25 Meeker Street (street/p. o. box)
	Succasunna (city) N.J. 07876 (zip code)
District Telephone	1-973-584-2799 Fax 1-973-252-1434 E-mail: DMack@Roxbury.org
Chief School Administrator	Mr. Mack
Nominated School #1 (Proper Name)	Eisenhower Middle School
School Address	47 Eyland Avenue (street/p. o. box)
	Succasunna, N.J. 07876 (city, zip code)
School Telephone	1-973-584-2973 Fax 1-973-584-4529 E-mail: JDelalma@Roxbury.org
School Principal	Mr. John DeRelma
Program Developer(s)	Mrs. Sandy Sward and Mrs Janet Vignola
Chief School Administrator's or Charter School Lead Person's Signature	

FOR USE BY COUNTY SUPERINTENDENT OF SCHOOLS ONLY

Approved: ✓ Yes ___ No **County Superintendent's Signature** _____

NEW JERSEY STATE DEPARTMENT OF EDUCATION

Code # 445
(for office use only)

NEW JERSEY
BEST PRACTICES
1999-2000 APPLICATION

Application Requirements:

- **RESPONSES to the information and the statements below must be ANONYMOUS.** No reference should be made to the names of the district or the school(s). Use the words "the school" or "the schools" in referring to the applicant in responding to the statements.
- **USE ONLY THE SPACE PROVIDED ON THE APPLICATION FORM on pages 1, 2 (if applicable) and 4 and THE NUMBER OF LINES SPECIFIED FOR RESPONSES to the statements.** Do not include any additional materials, as they will not be reviewed in the selection process.
- Application must be **keyboarded on 8 □" x 11" white paper, portrait** format. **Ten-point or larger computer font** or **twelve-pitch or larger typewriter font** must be used. (This sentence is in ten-point.)
- **KEYBOARDED RESPONSES** to the statements below must be **no more than a total of three pages. Keyboard the statement followed by the response.** Format your response to the number of lines specified.
- **The information on page 4 and the keyboarded responses** to statements must be printed or copied **on one side of the page**. **The information on pages 1 and 2 (if applicable)** must be printed or copied **on one side of the page**. Staple pages 1 and 2 (if applicable) and 4 and the keyboarded responses together.
- **The original application must be signed by the district chief school administrator or charter school lead person, indicating his/her approval.**
- **The original and seven copies of the application** must be submitted to the county superintendent of schools by **November 22, 1999**, with the **Itemized List of District Applications** form. Keep the seven copies of each application together with the original containing the signature of the district chief school administrator or charter school lead person on the top of each set.
- **FAILURE TO COMPLY WITH THE PROCEDURES FOR SUBMISSION OF THE APPLICATION MAY RESULT IN THE ELIMINATION OF THE APPLICATION..**

The following data is required to assist the panelists in the evaluation of the application:

Type of School / **Grade Levels**

___ Elementary School	___
✓ Middle School	8
___ Junior High School	___
___ High School	___
___ Other: ___	___

Practice Name MATS - Mathematics As a Tool of Science (A Team Experiment)

Number of Schools with Practice 1

Number of Districts with Practice 1

Check the ONE CATEGORY into which the practice best fits.

___ Arts (Visual and Performing Arts)	___ Educational Technology	___ Safe Learning Environment
___ Assessment/Evaluation	___ Health and Physical Education	___ School-to-Careers/Workplace Readiness
___ Bilingual Education and Diversity	___ Language Arts Literacy	✓ Science
___ Citizenship/Character Education	___ Mathematics	___ Social Studies
___ Early Childhood Education Programs	___ Professional Development	___ Special Education
___ Educational Support/Guidance and Counseling Programs (services contributing to high student achievement.)	___ Public Engagement (family involvement and partnerships with business, community and/or higher education.)	___ World Languages

1. Describe the practice proposed for recognition, and list its objectives. Detail how the practice is innovative, how it promotes high student achievement and how it can be replicated. **(Maximum of 50 lines for response)**

2. Describe the educational needs of students that the practice addresses and how they were identified. List the *Core Curriculum Content including the Cross-Content Workplace Readiness Standards** addressed by the practice and describe how the practice addresses the standard(s). **(Maximum of 50 lines for response)**

3. Document the assessment measures used to determine the extent to which the objectives of the practice have been met. **(Maximum of 60 lines for response)**

*The May 1996 edition of the ***Core Curriculum Content Standards*** published by the New Jersey State Department of Education was disseminated to all districts and charter schools and is available on line through the department's website at http://www.state.nj.us/education

1. ***"Describe the practice proposed for recognition, and list its objectives. Detail how the practice is innovative, how it promotes high student achievement and how it can be replicated."***

MATS –MATHEMATICS AS A TOOL OF SCIENCE (A Team Experiment) is an interdisciplinary unit designed to have students each participate in a science experiment in which math is used extensively.

DAY 1: The students are read a quotation that questions if there is a limit to the number of photographs a person can accurately remember. Students are then presented with the actual experiment. They will each observe 60 unique photographs. Each photo will be observed for 20 seconds. One week later they will observe the same photos alongside another photo for the same length of time. They are asked to hypothesize how many of the original photos they believe they will be able to correctly identify one week later.

Students use lab notebooks to record both the problem being investigated and their individual hypothesis. These hypotheses are also entered as data in a survey completed by each participant. The team, as a group, then observes each of the selected photos. The collected surveys are used to create a raw data sheet used to determine a team hypothesis.

Working in small groups, each person is given a copy of the raw data which is used to produce a frequency table, draw a histogram, and compile the mean, median, and mode. Although the group works together to help one another and to organize the information, each student must produce his own histogram and related set of information. Once this is complete, each student uses the data and histogram to write three good analysis statements.

DAY 2 (one week later): Students are assembled to observe each of the 60 original photos now paired with a new unique photo. As the pair is shown, each student records on a scantron sheet, which of the two photos was shown the week before. A second raw data sheet is produced from their results. Students are asked to: produce a second frequency table, histogram and related information for the new data, analyze the data from both days, write three meaningful statements, write a conclusion related to his/her personal hypothesis, and use the data to answer the question "What conclusion can you come to about 8th graders and pictures?"

OBJECTIVES:

1. Students will participate in a scientific experiment using the steps of the scientific method.
2. Students will write a hypothesis concerning the number of pictures they will recall after one week.
3. Students will organize and analyze the data from their hypotheses and observation results into frequency tables, means, medians, modes, and histograms.
4. Students will analyze the data using the graphs to come to conclusions.
5. Students will come to a conclusion as to their ability to recall pictures.

This practice is innovative and reproducible because it is a true blend of mathematics and science. Each student is the participant in an actual experiment. Techniques used follow standard scientific practice and format. This practice uses technology via a computer, LCD projector and a series or Power Point presentations to present information and the test material in a uniform, reproducible format. Each photo is seen for the same amount of time. Each student sees the same set of photos at the same time. This eliminates a possible variable during the experiment. Based on Chi-square analysis of previous results, the photographic recall experiment used is reliable and produces statistically significant, reproducible results.

Although the use of technology adds excitement to the IDU, other methods could be used to present photographs to the students. The basic concept of math as a tool of science could be used with other experiments with equally good results.

It promotes high student achievement by capitalizing on the excitement of a real experiment. The students become so interested in the outcome of the experiment that they eagerly perform the analysis needed to obtain the answers. Group work enables students to share the task of organizing the raw data and writing analytical statements resulting in higher quality individual work. Students will use the write-up of this experiment and their histograms as models throughout the school year. This again results in higher student achievement.

2. ***"The educational needs of students that the practice addresses and how they were identified":*** Students need to understand the relationship between subject areas: in this case between mathematics and science. From classroom observation, we found that material learned in one class was not always carried over to the other class. Further it is important for eighth grade students to understand and use the scientific method. During the scientific process, they must organize information and use it to analyze data, create graphs and come to meaningful conclusions. Students need to understand the importance of organization in achieving reliable results. In addition this IDU naturally leads to a discussion of memory and ways to recall information

"Specific* Core Curriculum Content and/or Workplace Readiness Standards *addressed by the practice with description of how the practice addresses the standards":

•Cross-Content Workplace Readiness

°*Standard 2(1,4,8): All students will use technology, information and other tools*: Students observe the use of technology in the presentation of 120 unique, scanned photographs. Scantrons are used to collect and evaluate data. In order to accomplish the task of finding the mean for many pieces of data, students need to use calculators. Some students also use computers to organize the data.

°*Standard 3 (1,2,3,7,8,9,10,12,13): All students will use critical thinking, decision making, and problem solving skills.* Students define the problem, formulate hypotheses and make observations. Students determine how to: organize information, draw histograms, write meaningful, related statements and come to conclusions.

•Mathematics

°*Standard 4.2(2,9): All Students Will Communicate Mathematically Through Written, Oral, Symbolic, and Visual Forms of Expression.* In order to complete the assignments, students discuss the problem together, write a hypothesis, construct frequency tables, draw histograms and compose their conclusions.

°*Standard 4.3(1,6,11): All Students Will Connect Mathematics To Other Learning By Understanding the Interrelationships of Mathematical Ideas....* The title of the IDU, "MATS, Mathematics as a Tool of Science", explains to students the interrelationship of mathematics and science and the IDU requirements demonstrate to them the role that mathematics plays in science. .

°*Standard 4.5(1,5,8): All Students Will Regularly and Routinely Use Calculators, Computers, Manipulatives ....* Students use graphing calculators to analyze the data. Computers are also available for data analysis.

°*Standard 4.12 (1,3,6,9,10,11): All Students Will Develop An Understanding of Statistics And Probability And Will Use Them To Describe Sets Of Data, Model Situations, And Support Appropriate Inferences And Arguments ....* Students use mathematics as a tool to solve a scientific problem. They collect, organize and analyze data in both chart and graphical form. They calculate the mean, median and mode of the results. The data is then used to formulate new hypotheses.

°*Standard 4.16(1): All Students Will Demonstrate High Levels of Mathematical Thought Through Experiences Which Extend Beyond Traditional Computation, Algebra, and Geometry.* This IDU uses the core curriculum content in a unique way that is both challenging and interesting. Students use mathematical tools and scientific problem-solving to discover the power of pictures.

•Science

°*Standard 5.2(1,5,7,8,9,15): All Students Will Develop Problem-Solving, Decision-Making and Inquiry Skills, Reflected By Formulating Usable Questions and Hypotheses, Planning Experiments, Conducting Systematic Observations, Interpreting And Analyzing Data, Drawing Conclusions and Communicating Results.* Students develop hypotheses, conduct systematic observations, organize, interpret, analyze data by using charts and graphs, draw conclusions and communicate through written results. See Standard 3.

°*Standard 5.4(2): All Students Will Develop An Understanding Of Technology As An Application of Scientific Principles.* Students see technology control the timing in an experiment to eliminate a variable.

°*Standard 5.5(1,3,4,7,10,): All Students Will Integrate Mathematics As A Tool for Problem-Solving In Science, And As A Means Of Expressing And/Or Modeling Scientific Theories.* Students use mathematics as a tool to solve a scientific problem. They collect, organize and analyze data in both chart and graphical form. They calculate the mean, median and mode of the results. The data is then used to formulate new hypotheses.

3. "The assessment measures used to determine the extent to which the objectives of the practice have been met." Three assessment measures have been used: two rubrics, one for each day of the IDU, comments of students in mathematics journal entries and a write up of the experiment in their science lab notebooks. The following rubrics were used:

RUBRIC-Day 1

This is worth 25 points in Science class and 25 points in Math class day 1 and 30 points in each class day 2.

I. Frequency Table 2 4 6 8 10
- Do you have three straight lines?
- Do you have titles for each column?
- Do you have equal intervals?
- Does the total add up to the total amount of data?

2. Histogram 2 4 6 8 10
- Did you use a ruler?
- Do you have equal intervals?
- Did you label the axis?
- Did you title the histogram?
- Did you color in the bars?
- Did you include a key?

3. Analysis 1 2 3 4 5
- Did you find mean, median, mode?
- Did you write 3 meaningful statements?
- Did you use complete sentences?

RUBRIC-Day 2

I. Frequency Table 1 2 3 4 5
- Same as Day 1

2. Histogram 2 4 6 8 10 12 15
- Same as Day 1

3. Analysis and Conclusion 2 4 6 8 10
- Did you find mean, median, mode?
- Did you write 3 meaningful statements?
- Did you write a conclusion that answers your hypothesis?

On the second day of the assignment, more weight was given to the analysis and conclusion than on the first day. Teacher observation saw great improvement in the quality of the second set of histograms.

We also analyzed the success of this project through student comments. Students were asked to respond to the question in their journal: "What did you learn from the IDU?" Examples of student response follows: "Math is a big tool of science." "I learned that both math and science go hand-in-hand and in science you need frequency tables and histograms." "Math makes science easier." "I learned how math and science work together."

Finally, the write up in science laboratory notebooks demonstrated a clear understanding of the individual parts of the scientific method. The students used the individual hypotheses from day one (total photos expected to be recalled correctly) to develop a team hypothesis. They used the histogram from day two to conclude that eighth graders underestimate their ability to recall pictures. We believe that we will reap the benefits of this IDU throughout the school year.